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ABSTRACT

As one in a series of test items collections developed by the Assessment and Evaluation Unit of the Directorate of Studies, the guide gives a wide range of questions and activities for the manipulation of scientific equipment to allow assessment of students' practical laboratory skills. Instructions are given to make norm-referenced or criterion-referenced tests and to evaluate the results. Sample answer sheets are provided. Test outlines in the guide consist of questions, procedures, equipment lists, special requirements and suggested grading of procedures. Science processes of measurement, drawing, dissection, observation and experimental methodology in adhesion, cells, circulation, color and other areas are outlined. Teachers may alter, modify or delete any test to suit program purposes. (CM)

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SCIENCE

LIBRARY OF TEST ITEMS

Practical Testing Guide

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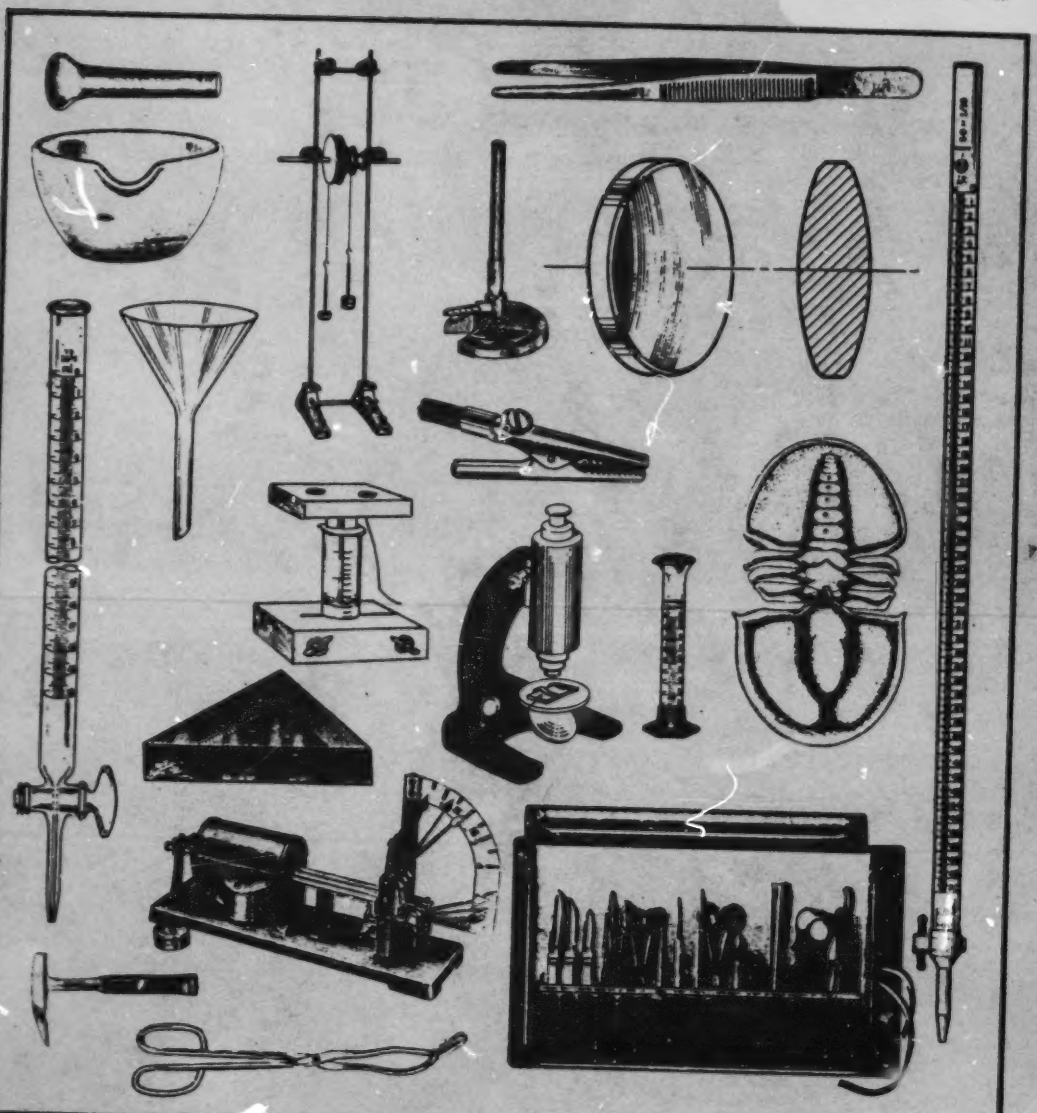

Volume Four

INTRODUCTION

Practical testing is required under the current Science syllabus. The available evidence suggests that most "practical testing" does not *require* any experience of practical work, although success may be *facilitated* by prior practical experience.

This collection of ideas has been prepared to show teachers how they may set up practical tests which require the student to manipulate apparatus to arrive at an end *product* which can be assessed.

A further collection of ideas is under development in which the criterion of success is the *process* of manipulation. These will be released in early 1979 as checklists of correct actions associated with different pieces or sets of apparatus, or activities, such as the hand lens, the ray box kit, and the preparation of a microscope slide. These require teacher observation of individual pupils.

Neither of these collections is either exhaustive or prescriptive. Teachers are free to alter, modify, ignore or use *in toto* any part of this collection which suits their purpose. It is the hope of the developers that this format will stimulate some science departments to write their own tests. They further hope that these new developments might be shared.

Further suggestions, requests for new developments, and comments about errors and difficulties would be appreciated. All communications should be addressed to

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Many of the people who made suggestions did not give their names. To that anonymous mass, all science teachers owe their thanks.

Those who did give their names include (in order of receipt):

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Roger Graham	Kiama H.S.
Ruth Rudkin	Willoughby G.H.S.

Like the anonymities, these contributors will recognise their ideas in the final product.

As with the other initiatives which have come from the School Certificate Development Unit, this project arose from the interaction between S.C.D.U. staff and practising teachers who meet together every second Saturday morning.

Brian Jarman (Turramurra H.S.) and Gaye Rosen (U.N.S.W. School of Education) took a nebulous idea from Peter Macinnis (S.C.D.U.) and produced a format which proved to be a useful skeletal framework.

The writing team then took over. In alphabetical order they were Mary Blackburn (Westfields H.S.), Eva Copeland (Moriah College), Shayne Fegent (now at Killara H.S.), Kim Fillingham (Killara H.S.), Brian Jarman (Turramurra H.S.), Jackie Keith (then at S.C.D.U. now at Dulwich H.S.), Peter Macinnis (S.C.D.U.), Kevin Molyneux (Cabramatta H.S.), Gaye Rosen (U.N.S.W.), Ian Scott (Turramurra H.S.), and Brian Shadwick (Riverside G.H.S.).

The writing team then reviewed each other's work.

Typing was by Alison Adlard and Sharon Webb, both of S.C.D.U.

Artwork was by Ian Munro and Jackie Keith, both of S.C.D.U. Ian also designed the cover.

Brian Jarman wrote the introduction with Brian Shadwick.

Peter Macinnis made the tea and coffee and did the general editing.

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What are practical tests?

* Practical tests are designed to allow teachers to assess their students' ability in the *skills area* of the aims document of the Science syllabus.

* These tests cannot be done entirely with pencil and paper. Most will involve the manipulation of equipment by students or teachers.

There are tests which purport to measure practical skills but which in fact do not. For example:

i) a test item which involves showing a picture of a test-tube and the question, "what is this?" is testing, recognition of apparatus and is not a practical test.

ii) a test item which shows several pieces of apparatus and asks, "which one would you use to boil water?" is testing knowledge of what apparatus to use and is not a practical test.

iii) a test item asking "what colour is the streak of a given mineral?" is only a practical test if the student actually carries out the streak test.

* The tests in this manual are designed to give teachers a wide range of questions and situations which could be used to measure practical skills.

Format of tests in the collection

* The practical skills dealt with in these tests cannot be assessed using the other material in the Science Library of Test Items. Further these tests *cannot* be preprinted in a way that allows them to be duplicated and handed out to the students in the same way as the other items.

* After careful consideration it was decided to use the following format

- the title of the test. (e.g. "Adhesion") (see page 15).
- the skill being tested. (e.g. "Experimental methodology").
- examples of questions that you can ask of students (column 1).
- the procedure that should be followed in organising the test and setting up the activities (column 2).
- equipment lists to assist your laboratory attendant (column 3).
- special requirements including hints, potential problems etc. (column 4), and
- a suggested marking scheme (column 5).

The tests in the collection

A detailed index is given, starting on page 63. This covers both content and processes.

Uses of practical tests

The type of practical test you choose depends on the information you want to obtain from the test.

. You could construct a norm-referenced test* (i.e. one designed to rank students) by selecting questions of medium difficulty that cover a range of objectives. Questions that are too easy or too difficult will not give you adequate discrimination.

. You could also construct a criterion-referenced test* (i.e. one designed to assess mastery of a particular objectives by selecting questions designed to test that particular aim.

Time-tabling the test

* If the whole Year is to be given a norm-referenced practical test as part of their science assessment then the test can be time-tabled together with other examinations.

* If your school does not have 'time-tabled examinations' and you have parallel classes, then it should be possible to schedule the test in the normal time-table if you have enough equipment.

* In some schools it may be impossible to schedule a practical test in faculty time and special arrangements will have to be made with your Principal and other subject heads.

* If you wish to give a criterion-referenced practical test, then the timetabling may depend on your teaching methods.
For example, if you use block teaching then the test may be given to a whole class at the same time.
If using a more individualised approach it may be given at different times, depending on the particular students' progress.

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* This matter has been fairly widely discussed in the literature which attaches to the Mastery Testing Programme. A norm-referenced test asks the question "How does student X compare with the rest of his/her group?" A criterion-referenced test is concerned with the question "How well does student X perform a specified task?" The student is not ranked by a criterion-referenced test: he/she is placed in one of two groups:
(i) those who need no further instruction on this skill, or
(ii) those who need further instruction on this skill.

While the same *test items* may be used for either purpose, a test constructed for one purpose would not usually be suitable for the other purpose.

Organising your laboratory

* With 30 or more students in a class, considerable thought must be given to the organisation of the test.

* The number of students in the laboratory actually doing the test will depend on the nature of the test and the facilities available.

* The test should be designed so as to occupy as many students as possible and to minimise movement and cheating.

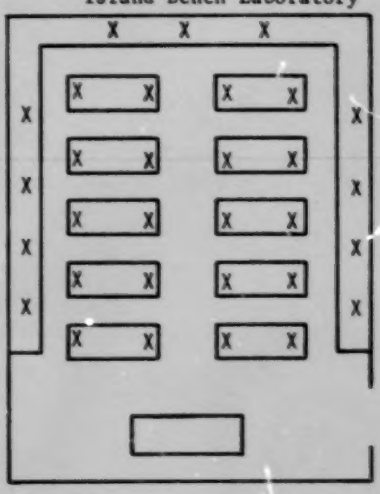
* Holding and supervision arrangements may need to be made for students not actually engaged doing the test. Adjoining classrooms and courtyards can be used for this purpose. Students who have done the test should not be allowed to mix with students waiting to do the test.

"No-movement" organisation

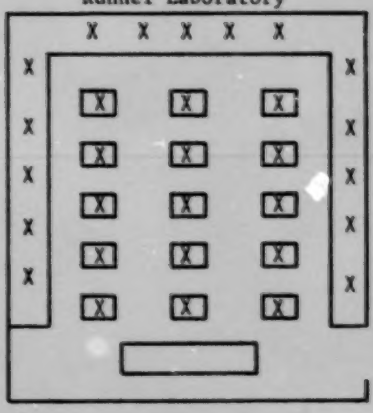
* This can be used when you have plenty of equipment available. For example determining the physical properties of minerals or identifying minerals using a key. With careful spacing, and supervision of students, the whole class could do this practical test.

* Some possible station arrangements might be:

Island Bench Laboratory



Runnel Laboratory



* If gas, electricity or water are required the number of stations will be reduced to 15-20 depending on the type of laboratory.

Rotating organisation

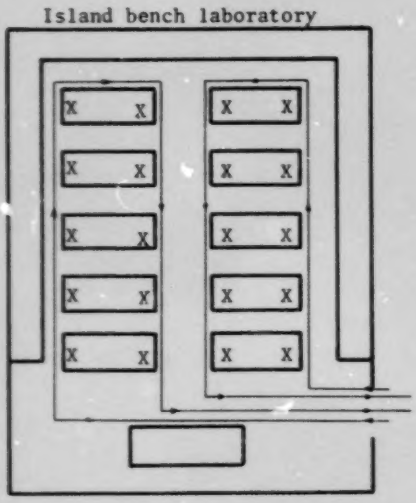
* If equipment is limited and if the test involves a number of tasks then a 'rotating organisation' may be required.

* Most Norm-referenced practical tests will require students to move from station to station.

* Time limits will need to be set to prevent queueing.

* Some possible rotating organisations based on 40 minute periods are:

Island bench laboratory

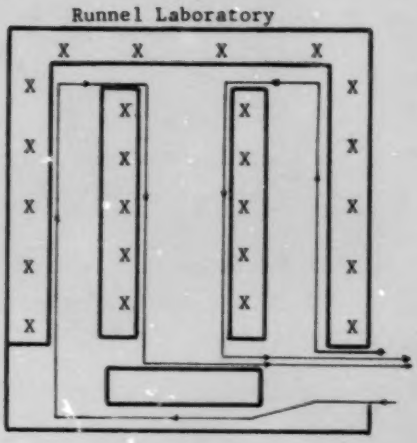


* With this organisation 30 students can perform 10 tasks each taking 2 minutes. Total time for the test would be 50 minutes.

* One disadvantage of this system is that 12 students at any one time are waiting. It may be possible to utilise the peripheral bench space and the teacher's bench.

* Setting up 10 additional lab. stations will reduce the testing time to 20 minutes.

Runnel Laboratory



* With this organisation 30 students can perform 12 tasks each taking say 2 minutes. Total time for the test would be 54 minutes.

* Eight students at any one time are not actively engaged doing the test.
One disadvantage of "Runnel Laboratories" is the reduced number of gas, water and electricity outlets.

* Setting up 6 additional lab. stations, increasing tasks to 15 (use 2 sets of 15, totalling 30 stations), reduces testing time to 30 minutes.

Setting up the laboratory

* Up to one period may be needed to set up the laboratory, and some time will be needed to clean it up.

* Laboratory attendants, can be used extensively in the setting up, administering and cleaning up stages of practical tests.

* Each station will need to be numbered so that it correlates with the question number on the answer sheet.

* Instructions for the activities will need to be provided. These can be on cards at each lab. station or incorporated into the answer sheet.

Time limits

* An element of speed is important in selecting those students who really have the skills.

* If no limits are set, then some students may score through trial and error manipulations.

Instructions to students

* Preliminary instructions may be given to students
- the lesson before
- outside the laboratory
- in the building, room etc.

* Instructions should include advice on
- movement
- time limits
- recording of answers
- following lab. station instructions etc.

Recording answers

* Work sheets which can be filled in by students are probably the best means of recording student responses.

* Students should collect these as they enter the laboratory and hand them in as they leave.

* Questions asked on the work sheet should be specific and unambiguous.

* Some examples of answer work sheets are given on the next 2 pages. When designing the work sheet, design it so as to simplify marking.

SAMPLE ANSWER SHEET

NORM-REFERENCED PRACTICAL TEST

Name _____ CLASS _____

Station 1. The mass of the unknown object A is
The mass of the unknown object B is

Station 2. The length of the piece of wood is

Station 3. The diameter of the glass rod is

Station 4. The colour of the streak from the black mineral is
The colour of the streak from the green mineral is

Station 5. The result of adding Solution A to Solution B was

Station 6. The unknown animal was

Station 7. How many crystal types were in the dish?

Station 8. The strongest adhesive was

Station 9. The pH of solution A was
The pH of solution B was

Station 10. The temperature of the ice-salt mixture was

HAND THIS SHEET IN BEFORE YOU LEAVE
THE ROOM.

SAMPLE ANSWER SHEET
CRITERION-REFERENCED TEST
(Measurement)

Name _____ CLASS _____

Instructions: In front of you are

* Two pieces of glass tubing (marked 1 and 2)
* A glass rod (marked 3)
* A glass marble
* A steel ball bearing
* A wooden rule
* Vernier calipers
* A micrometer screw gauge
* A spherometer
* A centigram balance

Q1. What are the measurements of glass tubing 1? _____

Q2. What are the measurements of glass tubing 2? _____

Q3. What are the measurements of glass rod 3? _____

Q4. What is the diameter of the marble? _____

Q5. What is the diameter of the steel ball bearing? _____

etc.

It will be noted that although questions are repeated several times, a correct choice of instrument needs to be made. If stations are used, this cognitive component could be avoided by supplying one item and one instrument at each station.

Marking

* Design a marking scheme which proportions the marks according to the aims of the practical test.

* In a norm-referenced test an attempt should be made to design a marking scheme which gives a good spread of marks across the sample. Practically, this is only feasible for questions which carry several marks (say 5 or more).

* In a criterion-referenced test, the student either satisfies the pre-determined criteria or not, and the marking scheme should reflect this.

Evaluating the results

a) In a norm-referenced test you are trying to rank students across the full range of marks.

* In this type of test it is useful to have information on how students performed on each question, so that you can make judgements about the suitability of the question.

* This can be done by -
- markers keeping a tally of the marks for each question, or by
- asking students to indicate, by show of hands who scored 0, 1, 2 ... for each question.

* If between 30-70% of students get a question correct, it may be considered to be a "good" item.
If fewer than 30% get the question correct, then it may be too difficult. If more than 70% score, the item is too easy to suit norm-referencing purposes. In these cases, the question should be revised or deleted as it is not discriminating between students.

* The Facility (or Difficulty) Index of a question (the percentage who answer correctly), can also provide feedback on teaching. It could be that the item is not really "too hard", but that it is unsuitable for your class, or for what or how you taught.

b) In a criterion-referenced test you are attempting to determine whether or not a student has satisifed the stated objective(s).

* Ideally a criterion-referenced test should contain several items pertaining to each objective (and therefore fewer actual objectives per test).

* If a student has satisfied a particular objective then he or she should score highly on items relating to that objective (75% or better would be a good level - many people use 80%). For example, suppose a test contains 4 items purporting to evaluate a particular object. If a student gets 3 or 4 correct then he/she has satisfied the objective (i.e. the criterion). If the student gets only 1 or 2 items correct then the objective has not been achieved. In this situation remedial work should be given.

1c) Designing your own practical tests

a) Pre-test

* Construct a grid similar to that shown:-

Objectives	Activities	Equipment	Questions	Marking

* Write your objective realistically and concisely. Some suitable forms are
- can the student *place an ammeter in a circuit?*
- can the student *correctly determine a mineral's hardness?*
- can the student *read a thermometer correctly?*

The sections in italics above are not behavioural objectives in the classical form: they lack any clear *performance specifications.* That will come when the marking scheme is determined.

* Select activities which purport to evaluate the objectives. Give careful consideration to the degree of difficulty of the activities. Remember:-

(i) A norm-referenced test
- many objectives are usually tested.
- usually include only one (two) questions per objective.
- questions should have facility index 0.3 to 0.7 so as to discriminate between, and therefore rank students.

(ii) In a criterion-referenced test
- few objectives are tested.
- contains several questions per objective.
- questions may have a higher facility index than in norm-referenced tests, and generally speaking, should be 0.7 or higher.

In both types of tests (in the absence of pre-test data regarding facility indices etc.) teachers will have to make subjective judgements concerning the difficulty of each question, so that it meets facility requirements.

(iii) The stage of intellectual development of the group (concrete transitional, abstract) must be considered when designing activities.

* Write the questions for each activity. Keep in mind the "weight" you wish to give each objective and the format of your answer sheet.

* Design a suitable marking scheme and tally sheet for post-test evaluation.

* List the equipment required for each activity.

* Call a faculty meeting to discuss the test.

* As a consequence of decisions made at the meeting prepare student instruction cards, and answer sheets.

b) Post-test

* Call a meeting as soon as possible at the marking to discuss and analyse:

(i) your organisation

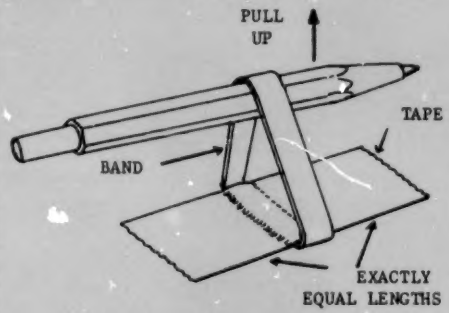
(ii) the test activities

- did they have the anticipated facility indices?

If not, then is the fault in the activity, the questions, or your teaching.

* Record the recommendation of the meeting on with a copy of the test and file for future use.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Examine this animal and state whether it is a herbivore, carnivore or omnivore. Give a reason to support your answer.		. Suitable live animal such as a dog, cat, rabbit or mouse (skulls can be used if no live animals are available).	The adaptations should be clearly discernable, so the students can "readily infer" how the adaptation assists the organism to cope with its environment.	. 1 mark for stating whether it is a herbivore, carnivore or omnivore. . 1 mark for a reason justifying the answer.
* How is this fish adapted to living in water? Give a reason for each adaptation.		. Live goldfish in water, or other appropriate animal		. 1 mark for each adaptation. . 1 mark for a reason to justify the adaptation.
* Examine this flower, then state how it is pollinated. Give a reason for your answer.		. Use flowers such as: - carnations, hibiscus etc for insect pollination - *Casuarina*, grass flowers etc for wind pollination.		. 1 mark for stating how the flower is pollinated. . 1 mark for a supporting reason.
* Examine this fruit, then state how the seed inside it would be dispersed. Give a reason for your answer.		. Use fruits such as: - succulents (e.g. apples) eaten and passed in faeces. - dandelions, wind blown - burrs, caught in fur - coconut, water dispersal		. 1 mark for stating how the seed is dispersed. . 1 mark for a supporting reason.

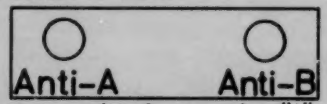
Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* How far was the band stretched above the bench for each type of tape. * Arrange your results into a table. * Draw a box graph of your results. * State one conclusion that can be drawn from the results. * What is the purpose of this investigation? * Give one possible application of this work.	1. Tear off a piece of tape exactly 5cm long. 2. Loop the rubber band around the tape and stick it to the bench. 3. Insert your *Biro* through the band and pull vertically upwards as illustrated.  4. Record the height of the *Biro* at the instant the tape pulls away from the bench. 5. Repeat steps 1-4 with 5cm strips of the other tapes provided or - 6,7,8,9cm lengths of the same tape or - new 5cm strips of the same tape on different surfaces (e.g. wood, glass, cardboard, masonite, plastic etc) - different sized rubber bands and new 5cm strips of tape or - different widths of the same tape (or different band aids) with the same rubber band.	. 30cm rule . rubber bands . various adhesive tapes (*Durex*, insulation tape, masking tape, book binding tape etc) . scissors . surfaces as required	Students should be warned not to touch the sticky side of the tape with their hands.	Marks should be awarded for: - acceptable results - an acceptable results table - an appropriately labelled graph - a relevant conclusion - a correct purpose - a logical application

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Describe each reaction as you observe it at each lab. station. OR Use the key to identify the anion in each of the unknown chemicals (A, B, C ...) that has been given to you. OR Follow the instructions to prepare the gases and use the identifying tests on the sheet of paper to identify each gas.	POSSIBLE AIMS These reactions could be used to a) test observations b) test ability to: - follow instructions - write up experiment etc. c) test ability to use a key, identification chart, etc. to identify unknown chemicals d) test ability to prepare and identify a gaseous product of a chemical reaction etc. PROCEDURE In all cases ... set up lab. stations which involve the chemicals required for each particular reaction to be observed OR ... provide each student (bench) which a basic set of chemicals, and each student with a number of unknown chemicals to either - identify gases produced or - identify the anion in each chemical INSTRUCTIONS TO STUDENTS Provide instruction cards which clearly indicate procedure to students. Set a time limit or let students work at their own rate; total number done is an indication of skill in techniques (way). CONTINUED ON NEXT PAGE	The following chemicals could be used. Chemicals may be used in solid form or as dilute solutions. UNKNOWN ANIONS a) sodium sulphate b) iron sulphide (crushed) c) sodium sulphite d) sodium nitrite e) sodium carbonate f) sodium chloride g) sodium bromide h) sodium iodide i) sodium nitrate (If a sodium salt is not available use the corresponding potassium salt. Note: Use only group 1 metal salts as other metal ions may give precipitates with reagents. REAGENT TO BE ADDED 1) 2M hydrochloric acid 2) 0.05M barium chloride (10g/L) 3) 0.05M silver nitrate (7g/L) 4) concentrated sulphuric acid 5) 2M ammonium hydroxide 6) 2M nitric acid 7) 0.1M iron (II) sulphate solution (15g/L) CONTINUED ON NEXT PAGE	Depending on the purpose the teacher will have to prepare instruction sheets which: - give instructions as to what has to be done, viz, experimental requirements, written requirements. - give a key so that students can correlate reactions and identify the chemical unknown. - give identification reactions or tests for each of the gases used in the test. Students may need to be warned about concentrated H_2SO_4 Get students to work out now many tests they will (or may) have to do on each sample and to use amounts such that all tests will be able to be done on sample as given - deduct marks for those requiring more samples.	1 mark for each correct observation. OR 1 mark for each correct anion identified. OR 1 mark for each correct gas prepared and identified, plus marks for correct experimental write-up, observation etc. OR Could mark each write-up /10 (say) plus 1 mark bonus for each unknown correctly identified in the given time.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
CONTINUED FROM PREVIOUS PAGE	SUGGESTED COMBINATIONS (A + 2) white precipitate of barium sulphate ... will also get white precipitate with (E + 2) but these distinguished by reaction with HCl. (B + 1) hydrogen sulphide gas, know by odour or by reaction with lead acetate paper (turns black) (C + 1) sulphur dioxide produced - identify by odour or by turning potassium dichromate paper green. (D + 1) get nitrogen dioxide gas on heating - identity by brown colour. (E + 1) get carbon dioxide gas - limewater test. (F + 4) get chlorine gas - identify by colour, odour, acid reaction then bleaches moist blue litmus (as does SO_2). (G + 4) get bromine gas - identify by colour (red-brown). (H + 4) get iodine gas - purple colour. (I + 7 + 1 ml 4) - brown ring test (also works for D). (F + drop 6 + 3) get white precipitate silver chloride - turns purple in sunlight - soluble in 5. (H + drop 6 + 3) yellow precipitate of silver Iodide - insoluble in 5.	ADDITIONAL TEST REAGENTS . potassium dichromate paper (filter paper strips soaked in $K_2Cr_2O_7$ solution) . limewater . lead acetate paper . blue litmus paper WATCH OUT FOR THESE Some side reactions may also occur and may need to be exemplified on instruction sheets. e.g. (A + 3) will give a white precipitate of silver sulphate. (B + 3) will give a black precipitate of silver sulphide. (E + 3) will give a white precipitate of silver carbonate, so these precipitates (if $AgNO_3$ test is at end of instruction key) will indicate some failure to get a correct result with a previous test reaction.	CONTINUED FROM PREVIOUS PAGE	CONTINUED FROM PREVIOUS PAGE
22				23

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Measure the distance between A and B in centimetres and correct to one decimal place.		. Metre ruler . Paper with an interval AB marked on it A——————B	The suggested activities can be made more stimulating by: - choosing relevant measuring activities - using a range of liquids (water, glycerine, oil) - using different coloured liquids (potassium permanganate solution, fluorescein-dyed water).	In each case marks should be awarded for the correct magnitude and the correct unit. Students not knowing how to use a measuring device get no marks.
* Determine the mass of the coin to an accuracy of 0.1 g.		. Side arm balance . Coin		
* Find the time that the lead ball takes to travel from the top to the bottom of the liquid to the nearest 0.1 s.		. Stop watch . Lead shot . Glass tube and stopper . Liquid		
* What is the volume of the liquid in the measuring cylinder to the nearest millimetre?		. Measuring cylinder . Liquid		
* What is the temperature of the liquid in the thermos flask to the nearest degree?		. Celsius thermometer (0 - 110°C) . Thermos flask . Liquid		

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Identify the cell as plant or animal (e.g. filamentous algae, onion skin, cheek cells, unicellular animals) giving a reason for your choice.	This can be done using microscopes with prepared slides, viewers or projectors with 35mm slides or photographs.	. monocular microscopes and slides; and/or viewers or projectors and coloured slides; and/or photographs.	. Careful thought must be given to selection of slides of photographs to ensure clarity. Resources: 35mm slide sets accompanying the ASEP unit 'Cells and Life in Freshwater' 35mm film strip called "Photomicrographs of slides issued to schools" distributed by Teaching Resources, Division of Services	No mark for correct identification but mark for valid reason (e.g. animal because it lacks a cell wall).
* This is a slide of part of an animal tissue. (e.g. neurone, muscle, gut). Name the tissue giving a reason for your answer.				Mark for correct identification and additional mark for correct reason. (e.g. heart muscle, has many nuclei)
* This is a slide of part of a plant tissue. (e.g. root hair, stomates, parenchyma). Name the tissue giving a reason for your answer.				Mark for correct identification and additional mark for Correct reason. (e.g. underside of a leaf, stomates visible).
* Draw and fully label the cell (e.g. filamentous algae, *Euglena*, *Paramecium*) and all visible structures (i.e. organelles).				Marks for accuracy of diagram and for each correctly identified organelle.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* What type of blood cell is the pointer indicating (one for red and one for white blood cells)?	Identify an example of a red or white blood cell on 2 different microscopes and position pointers. Tape pointer and slide in position.	. 2 microscopes and 2 prepared slides of stained blood.	Use of senior microscopes would facilitate viewing.	1 mark for correct identification of blood cell type.
* Identify the type of blood vessel you can see. (e.g. one of artery, one of vein, one of capillaries in tadpole tail).	Use prepared microscope slides or 35 mm colour slides for arteries and veins. Capillaries can be observed in the tail of a live tadpole using a stereo-microscope. Keep tadpole's head covered with moist cotton wool.	. 2 monocular microscopes and slides (or 35 mm projectors and slides) . Live tadpole, stereo-microscope, moist cotton-wool; Petri dish bottom		1 mark for correct identification of type of blood vessel
* Look at the results of this blood group test and identify the blood types of the donor.	Set up slides as shown.  Choose donors with for example, "A" blood, "O" blood and "AB" blood.	. 3 slides and supply of anti-A and anti-B serum. . Small blood sample (4 drops) from donors . Lancets for pricking donor's finger	Locate suitable donors from staff and other students. Blood samples can also be obtained from hospitals, blood banks etc. if ordered in advance.	1 mark for correct identification of each donor's blood type.
* Identify the part of the heart indicated by red pin, green pin etc.	Dissect 1 or 2 sheeps hearts, pin coloured plastic headed pins in part to be identified.	. 1 or 2 sheeps hearts . Dissecting instruments and plastic trays . Coloured plastic pins	Ensure atria (auricles) are left intact by butcher.	1 mark for each correct identification of labelled part.
* Use the chemicals provided to identify the blood type of the samples provided.		. Dropper bottles of anti-A and anti-B serum . Blood samples on microscope slides		1 mark for correct identification of each blood type

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* How long does the ball take to travel through each liquid? * Record your results in a table. * Draw a bar graph of your results. * What can you conclude from your results. * What is a possible aim of this experiment? * Give a real life example of where this idea may be used.	1. Clamp the glass tubing in a vertical position and stopper the end. 2. Place a large beaker underneath the tube to collect any overflowing liquid. 3. Place a mark on the tube one metre from the top. 4. *Completely* fill each tube with different test liquids. 5. Instruct students to drop the ball and to time how long it takes to travel from the top, through one metre of liquid. Note: The bottom 20 cm of tubing is for the collecting of ball bearings.	For each test liquid you will need: . 120 cm length of large bore (about 1 cm) glass tubing . rubber stopper . retort stand . bosshead and clamp . 800 ml beaker . small ball bearings . stop watch Suggested test liquids: . water . glycerine . oil . alcohol . liquid detergent	The top of the tube should be within safe reach of students and it is suggested that the apparatus be set up on the floor against a bench.	Award marks for a - correct times of fall - result table - bar graph - acceptable conclusion - a correct statement of purpose - logical suggestion

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
	The purpose of this test is to determine whether a student can conduct an investigation, involving two variables, obtain data, graph the data and interpret the graph.			
* In this investigation you are investigating how X changes with Y. * Set up the equipment as illustrated. * Start the investigation and measure X and Y. Enter X and Y into your table. * Plot the points on the graph paper provided. * What pattern, if any, can you see? * Complete the graph by drawing in the line of best fit. * State in words the relation between X and Y.	This test is best done individually at the student's desk. Students can record their readings in the space provided on the graph paper.	The equipment required will vary depending on the particular investigation chosen. Some two variable investigations are: . temperature-time graphs for heating (water, M.P. etc.) . load-extension graphs (spring balance, rubber bands) . length-period of a pendulum	This test can be extended by including: - questions in which students have to interpolate and extrapolate information from the graph. - questions in which the student has to derive the mathematical relationship between the variables. - questions in which the student has to suggest possible sources of error and methods of overcoming these.	The allocation of marks will vary. It is suggested that marks be awarded for: . the correct assembling of equipment . collecting and recording data . correct marking of scales, labelling of axes, plotting of points, line of best fit, etc. . recognition of a pattern in the points plotted e.g. the points are in a straight line, points are scattered all over the graph paper etc. . a statement of the relationship between X and Y e.g. X increases as Y increases.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Using the ray box equipment show how white light can be broken into colours. * Which of the colours of the spectrum has been bent the furthest from its original path? * Which colours of your spectrum are <u>removed</u> when a red filter is placed in the path of the white light? * Remove the prism. Which colour is <u>transmitted</u> when a green filter is placed in the path of white light? * What is the appearance of the blue card in red light?	Each student is provided with a ray box kit and an answer sheet and works at his/her own bench. See also p. 52.	Ray box kit (including lamps, gates, triangular prisms, filters, coloured cards, white screen).	A darkened space is essential. This need not be the entire room but may be (i) a curtained section of the laboratory or the preparation room. (ii) a screened bench (iii) a large cardboard box	Marks should be awarded for correct positioning of the equipment and for correct observations. For example: - 2 marks for successful production of spectrum. (1 mark for manipulation of the ray box, 1 mark for manipulation of the prism) - 1 mark each for correct observations

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1(a) Measure 20 ml of each of solution 1 and solution 2. (b) Find the mass of each on the triple beam balance. (c) State which of the two solutions is more dense.	2 sets of items marked clearly A and B each with access to tap and sink, 100 mL measuring cylinder, 2 x 50 mL beakers, triple beam balance. Set A to have 2 solutions - solution 1 - 300 mL methylated spirits, solution 2 - 300 mL water. Set B to have 2 solutions - solution 1 - 300 mL methylated spirits, solution 2 - 300 mL salt water.	. Measuring cylinders. . Beakers. . Triple beam balances. . Solutions: methylated spirits water salt water	Label the measuring cylinders for use only with solution 1 or solution 2 OR make sure glassware is cleaned and dried as each student finishes. NB: labels should be written in ball-point pen on gummed labels, as felt pen is either water or spirit soluble.	Correct mass readings. Correct density alternative.

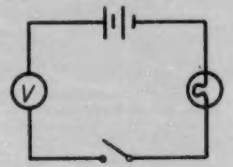
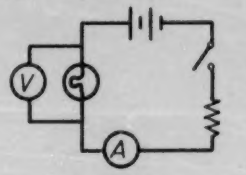
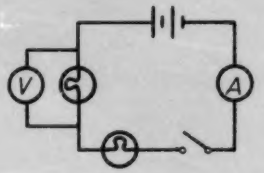
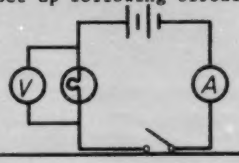
Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
Dissect this specimen and place the correct coloured pin in the parts that are to be identified. e.g.1: dissect this chicken wing and place 1. place a red headed pin in a muscle 2. a green headed pin in a hinge joint 3. a yellow headed pin in a ligament e.g.2: dissect this flower and place 1. a red headed pin in an anther 2. a green headed pin a stigma 3. a yellow headed pin where the seed will grow.	It is suggested that this test be done individually. Give each student a specimen, dissecting equipment and tagged pins.	. Specimens e.g. chicken wing sheep hearts pig or bull eyes flowers . dissecting equipment boards and trays scissors forceps . Pins with coloured plastic heads.	If hearts are to be used, the atria (auricles) must be intact and the major blood vessels should still be attached. Large numbers of eyes are available from the Metropolitan Meat Board, Homebush Bay.	Marks for: - the accuracy which each feature has been exposed - correct placement of pins.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Draw the apparatus using conventional scientific diagrams.	Place items to be drawn on teachers or students bench. Allow time limit for each piece or for total test. OR Set up some more complex set of equipment and require student to draw the assembled set.	Selected apparatus such as . conical flask . measuring cylinder . Bunsen burner . tripod . retort clamp . test tube . beaker . evaporating basin . circuit components		1 mark for each correct detail of each piece, e.g. - rounded base - open neck - lip - parallel sides - scale markings etc.
Draw the specimen provided, labelling all parts you can identify. Indicate the scale.	OR Provide students with the objects to be drawn (could also be asked to draw them to scale).	e.g. . distillation equip. . filtration equipment . electrical circuit . voltameter . electric cell e.g. . leaf . twig in bud . flower . insect, spider		Score maximum (say 10) and deduct 1 mark for each error in diagram or for each label left out.
* Draw what you see on the slide. OR Draw a carefully labelled diagram of one of the objects shown in the slide, photo, picture. OR Quickly sketch each animal shown, making sure you label its main features. OR	Project a slide (35 mm) onto a screen and give students a set time to complete the desired diagram. Project slides or show photographs/ charts etc. as required.	. 35 mm slide projector . screen . darkened room . slides e.g. ASEP "Cells" set or "Seashores" set.		Either award marks for each feature correctly drawn, or allow (say) 10 marks for each diagram and deduct marks for errors. OR Award 10 marks to best diagram and scale others accordingly.
CONTINUED ON NEXT PAGE (p. 27)	CONTINUED ON NEXT PAGE (p. 27)	CONTINUED ON NEXT PAGE (p. 27)	CONTINUED ON NEXT PAGE (p. 27)	CONTINUED ON NEXT PAGE (p. 27)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
CONTINUED	CONTINUED	CONTINUED	CONTINUED	CONTINUED
This animal is a(n) " ...." (insect" say. Quick sketch its main characteristics or special adaptions.				Simply scale each students work as A, B, C or satisfactory, unsatisfactory, excellent etc. (perhaps for profile)
* Draw a neatly labelled diagram of what you see under the microscope. What do you think it is, or what is it part of?	Set up microscopes with required slides. Allow time limit for each to be drawn and labelled. Rotate students through lab. stations until each has completed the required number. OR Set up bioviewers with selected photomicrographs from the biostrips. Allow time limit then rotate students through lab. stations.	. microscopes, lamps or good light source . prepared slides as selected - plant cells - animal cells - sperm, ova - mitosis etc. . bioviewers . selected strips		1 mark for each correctly drawn and labelled feature. 1 mark for identifying object drawn.
* Draw a neat diagram of slide 3 (say) on the biostrip you have been given. Label the parts (structures) indicated by the letters A, B, C ... on the slide. * What is the slide of, - (or part of)?				
* Draw a neatly labelled diagram of the model shown.	Have at front of class - a geological block model - human torso - ear model - eye model - chemical model etc. Allow time limit for students to complete work.	Model(s) as required.	Students near model will have an advantage so try to arrange them equi-distant from models or allow mobility. Try to obtain as many models as possible.	Grades may be easier or fairer to award than marks.

See also p. 28.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Draw the geological section (diagram) in three dimensions	Provide students with a copy of 2-dimensional diagram of some geological structure and ask them to expand it to 3-dimensions	. photo, slide, picture, . stencil of geological structure.		
* Draw the object shown to 0.5 scale (say) or life size etc.	Give student some object, or a picture of an object drawn to scale. Require them to redraw the object to a different scale.	. any object . pictures, stencil of objects drawn to scale		

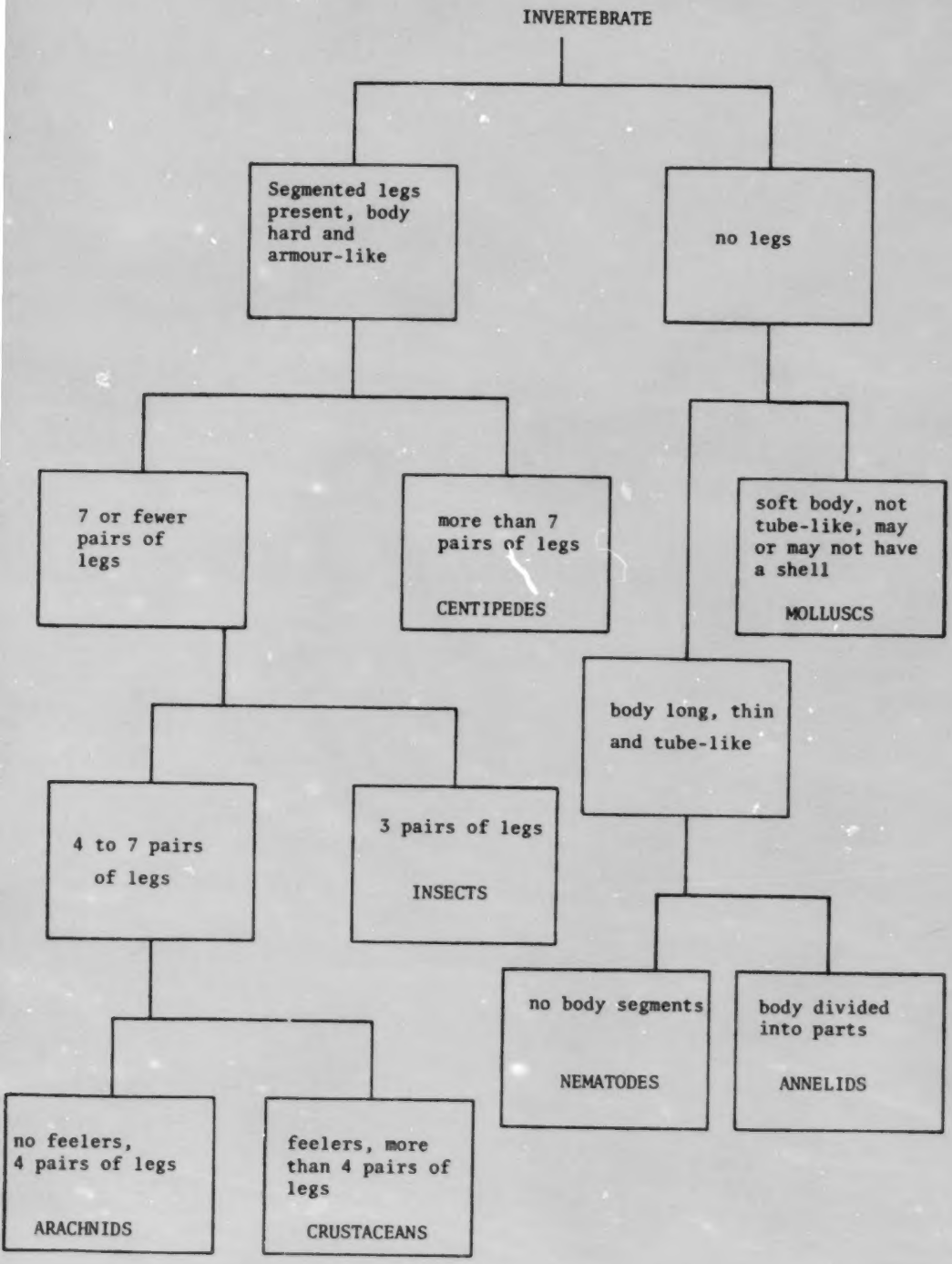
Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. What would be the circuit diagram (or drawing) of the simplest circuit using the parts provided?	e.g. 1. students are provided with battery (or power pack), switch, light globe, 3 connecting wires  (voltmeter in series)	. Batteries . Power packs . Switches . Wires . Alligator clips . Lamps . Resistors . Ammeters . Voltmeters . Circuit diagrams	Instruct students not to interfere with circuits already set up.	1 mark for circuit diagram (or drawing)
2. What is wrong with the circuit provided?				1 mark for correct observation.
3. By using the circuit provided what is the value of the resistance of the globe?	 	Final selection of equipment depends on question asked, and kind of students being tested e.g. could be extended to resistors in series and parallel, and electrical power.		1 mark for reading the meters. 1 mark for correct calculation.
4. By setting up the circuit from the diagram provided, what is the value of the resistance of the lamp?	 		Teacher personally checks the circuit and awards a mark (on e.g. a class list)	1 mark each for . correct circuit . correct meter readings . correct calculations
5. What is the current flowing in the circuit provided?	e.g. Set up following circuit.  	power source 7 connecting wires switch resistor ammeter lamp voltmeter	Instruct students not to interfere with the circuit set up.	1 mark for correct reading.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
6. Using the equipment provided measure and record the current flowing in the circuit.	Provide students with equipment to set up the circuit	power source 4 connecting wires lamp switch ammeter	Students to dismantle the circuit when finished before proceeding onto next question.	1 mark for correct reading.
7. Using the equipment provided, design a circuit to measure the total resistance of two resistors in parallel. Draw your circuit diagram. What is the value of the total resistance.	Provide students with equipment.	power source 2 ammeters voltmeter 2 switches 2 resistors 12 connecting wires	(As above).	4 marks (1 mark for circuit diagram, 1 mark for construction, 1 mark for meter readings, 1 mark for calculations).

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Which of the substances provided is an electrolyte? OR * Which of the solids provided are ionic solids?	Supply solutions in bottles labelled A, B, C etc., together with equipment for testing conductivity. OR Supply solid chemicals as required.	Solutions suggested: A: salt B: sugar C: kerosene D: alcohol E: hydrochloric acid F: distilled water G: copper sulphate Other equipment: . Transformer . 4 x connecting leads . stainless steel electrode with globe . switch . ammeter . microammeter . 400mL beaker . wash bottle of distilled water	Students should be required to wash electrodes between test runs.	Correct determination of electrolytes. Award marks for techniques as observed. Deduct marks for any fuses blown.
* Which solution is a strong electrolyte and which is a weak electrolyte? Which solutions would best be called non-electrolytes? OR * Arrange the solutions provided in order of their increasing strength as an electrolyte.	Supply solutions in bottles labelled A, B, C etc., together with equipment for testing conductivity.	Solutions suggested: Equimolar solution of: A: hydrochloric acid B: ammonia solution C: benzoic acid D: copper (II) sulphate E: sodium nitrate F: potassium hydroxide G: acetic acid H: kerosene I: alcohol J: tap water Other equipment: See above.	Electrodes will need to be washed with distilled water between readings. Arrange for a supply of spare fuses, or a full set of circuit breaker power packs to avoid blown fuses.	Award marks for: a) correct classification. OR b) correct order. c) observed laboratory techniques. Deduct marks for: a) fuses blown. b) messy benches.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
What substances, (starch, protein, fat, vitamin C, or glucose) are present in the food sample provided. OR Which of the food samples provided contain: - protein (say)	1) Provide each bench (or each student) with a kit of test reagents, papers and other necessary equipment. 2) Provide each student with selected food sample(s). 3) Provide each student with an instruction card specifying their particular task.	Test Reagents a) iodine in potassium iodide solution. b) biuret solution or paper - (1% $CuSO_4$ solution in 40% NaOH solution until the mixture becomes deep blue). c) test tape. d) brown paper. e) dichlorophenol - indophenol (D.I.P.) solution. Equipment a) mortar and pestle b) Bunsen c) test-tubes d) test-tube holder e) test-tube rack Food stuffs a) containing *starch:* bread, potatoes, rice, noodles, pasta. b) containing *protein:* pepsin, egg white, cheese c) containing *glucose:* boiled sweets, jelly beans, glucose, "Glucodin" d) containing *lipids:* olive oil, cheese batter, hot chips, Chiko roll. e) containing *Vitamin C:* ascorbic acid tablet (crush and dissolve to give clear solution) orange juice, capsicum, rose hip.		Award marks for correct determination of food components. Award marks for laboratory technique as observed. Award bonus (or penalty) marks for determinations in excess of (below) minimum requirements in time alloted.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
*Using the key provided, arrange each organism into its appropriate group. *Which animal of those provided is an arachnid (or whatever)? *What features of animal X cause it to be classified as an insect (or whatever)?	Place copies of keys and invertebrates: - at stations and rotate students OR - in trays on each bench and each student works through each specimen in the tray ——— An alternative approach is to provide each student with a key and use overhead transparencies or 35mm slides of some invertebrates.	. Specimens . Plastic embedded specimens . 35mm slides (optional) . Overhead transparencies (optional) . Trays . Hand lens (optional) . Tweezers (optional) . Key (See Mastery Test M2 for sample key) A *sample* key, derived from mastery test M2 is printed overleaf.	Specimens should have clearly observable features such as legs, feelers, body segments etc.	A mark for each correct classification.
This format	could also be used with such things as	vertebrates, plants and	rocks.	


INVERTEBRATE
Segmented legs present, body hard and armour-like
no legs
7 or fewer pairs of legs
more than 7 pairs of legs
CENTIPEDES
soft body, not tube-like, may or may not have a shell
MOLLUSCS
body long, thin and tube-like
4 to 7 pairs of legs
3 pairs of legs
INSECTS
no body segments
NEMATODES
body divided into parts
ANNELIDS
no feelers, 4 pairs of legs
ARACHNIDS
feelers, more than 4 pairs of legs
CRUSTACEANS

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
	It is envisaged that in this test students move from station to station and complete an answer sheet as they go.			
* Examine the operation of each lever and indicate by means of a diagram the location of the load, fulcrum and effort.	The equipment should be arranged so that students can operate the levers. For example, a board with nails in and hammer, cans and a can opener etc.	. Selected levers e.g. hammer, tweezers, can opener, bottle opener, door handle etc.	Depending on the ability of your students, levers whose operation is not immediately obvious should be selected.	1 mark for each correctly labelled diagram.
* Using all the equipment provided assemble a block and tackle machine to lift a load of 100g and determine its mechanical advantage.	The string should be cut to size beforehand and tied to the pulleys. Students should be told to dismantle the equipment when tney are finished.	. Retort stand . Bosshead and clamp . 2 single moveable pulleys . String . 2 mass carriers . 50g slotted mass	More complex pulleys may be substituted. On the answer sheet students should be asked to draw a diagram of their pulley system.	1 mark for a diagram of the correct pulley system. 1 mark for the correct mechanical advantage.
* How many times do the beaters rotate when the handle is turned once?		. hand operated egg beater or a hand operated drill and bit fitted with a cardboard disc; or an inverted bicycle	This activity can be varied by using a bicycle with gears.	1 mark for the correct number of rotations.
* Using all the equipment provided and the Principle of Moments find the mass of the plasticine.	Students should be told that they are not allowed to break the plasticine up.	. Retort stand . Capstan block fitted with a knife edge . Moment rule . String loop . Mass carrier . 50g slotted mass . Ball of plasticine.	The answer sheet should have a place for a diagram and the moment calculation.	1 mark for a correct diagram. 2 marks for the calculation.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. Measure the current and voltage for the electrical circuit for transformer settings A,B,C and D. * Graph the results. * Draw the circuit using the usual conventions. * What would I and V be on setting E? 2. Measure the time it takes a ball to roll 1 metre down a 5^0, 10^0, 15^0, 20^0 slope. * Graph results. * How long would it take a ball to roll down a 12^0 slope? A 25^0 slope? 3. Determine the way a rubber band stretches when successive masses are added (to 200g). * Graph your results * What would be the stretch with 300g mass?	Set up each bench with a different set of apparatus - may be able to set up two experiments on each bench. Set others around sides of lab to total of 10 different experiments. Rotate students through the experiments during double period - this allows an average of 7-8 minutes per lab station (more if fewer examples used). Several different examples may test identical skills, so each student may only need to do 5 examples (15 minutes each). (OR) Set up only 1 or 2 examples per test period and require a more detailed write-up. Over a long period a skills profile could be constructed for each student. (OR) Give students a list of possible experiments and ask them to select and prepare for as many as they think they can handle. Have students hand in a written preparation before the test lesson - set up requested. Repeat experiments several times in the year to build a profile. (OR) Give students preparation time (perhaps even research) for a particular experiment, then allow time to do it. (OR) Requests for students to extrapolate or interpolate from their results would follow later in the year when all students have completed their quota of exercises. A written test could then be given where	1) . Transformer . Variable resistor . Ammeter . Voltmeter . Switch . Wires . Instruction card . Graph paper 2) . Inclined plane . Metre rule . Chocks of predetermined size (or have the slope measure attached to the incline) . Stopwatch . Steel ball . Graph paper . Instruction card 3) . Rubber band . Mass carrier (50g) . Masses (25g, 50g) . Graph paper . Retort stand . Clamp . Metric rule . Instruction card	Try to frame a question within the confines of your experimental exercise which requires students to extrapolate and to interpolate from their results. May need extra exercises prepared to cater for the very fast workers.	This will be determined in part by the objectives of the test. e.g. * 10 marks per exercise if a short time limit applied (OR) * More, if a detailed report is required, e.g. 25 marks. (OR) If working towards a skills profile, A Grade A,B,C may be more meaningful. Marks could be awarded for * Write up, Method, Statement of Purpose Concluding statement * Results being tabulated Evidence of multiple readings. * Use of averages * Correct analysis of results. * Correct graph * Correct method of plotting points. * Correctly labelled axes

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
4. Determine the time taken for a pendulum to swing 5,10,15,20 times. * Graph your results. * How long would it take for the pendulum to swing 30 times? 12 times?	they use their results to answer the questions.	4) . Retort stand . Bosshead, clamp . String . Pendulum bob . Stopwatch . Graph paper . Instruction card		* Correct extrapolation, interpolation etc. * Could deduct marks for equipment needed but not specified in students plan.
5. Determine the time taken for 1 swing (called the period) of a pendulum which is 10, 20, 30, 40, 50cm long. * Graph your results. * What would be the period of a pendulum 60cm long? * How long would a pendulum with a period of 1 second be?		5) . Pendulum bob . Stopwatch . Graph paper . Instruction card . Strings of varying lengths e.g. 10,20,30cm.	5) Students may have to be advised that it is necessary to get the average of e.g. 10 swings to determine the period.	
6. Weigh 10,20,30,40 matches. * Graph these results. * Weigh an empty matchbox. * Determine how many matches are in the sealed box.		6) . Empty matchbox . Mass balance . 40 matches . Sealed matchbox containing unknown (by student) number of matches. . Graph paper . Instruction card	Teachers could predetermine the theoretical answers to some exercises e.g. pendulum swings, I,V, measurements, a ball down a slope. Others depend on student results as they are not physical contrasts e.g. stretch of band.	

MEASUREMENT (ANALYSIS-DESIGN)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
7. Using the apparatus provided, determine the volume occupied by the gas in the syringe as successive loads (books) are added. * Graph your results. * What would be the volume for a load of 2½ books? 5 books?		7) . Use Senior Boyle's Law apparatus . Graph paper . Instruction card . 4 largeish text books (Chem study or Smith & Smith size).		
8. Use the equation: Density = $\frac{\text{Mass}}{\text{Volume}}$ and the equipment to find the density of the mass. * How much space would 10 grams of the substance occupy? * What would be the mass of 15ml of this substance?		8) . Density mass . Balance . String . 100 mL cylinder . Instruction card		
9. How many spoons full of water are required to fill the beaker marked "X"? * What is the volume of 1 spoonful of water?		9) . Dessert spoon . 100mL measuring cylinder . 300mL beaker marked X . Instruction card	Requires evidence of average volume of spoon being calculated and used.	* 1 mark for correct calculation 1 mark for correct answer
10 Use the minigrid scale and the microscope to find the maximum length of the grain of sand. * Show your working.	Students could be provided with a microscope set up. (OR) Students could be asked to set up the microscope.	10). Mini-grid . Microscope . Sand grain . Paint brush . Lamp . Instruction card		* 1 mark for correct reading of mini-grid; 1 mark for correct answer.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
11 Calculate the volume of 20,40,60,80 small steel ballbearings. * Graph your results. * What would be the volume of 18 ballbearings, and of 95 ballbearings?		11). 100mL cylinder . 80 ballbearings . Graph paper . Instruction card	Other constant volume articles could be used e.g. marbles, coins, washers.	* 1 mark for each reading; 1 mark for plotting each point on graph. 1 mark for each answer.
12 Find the mass of the object provided using this equipment. * Show all your calculations	Instructions on any of these exercises can be as detailed as required. If no details are given, then marks could be awarded for experimental design.	12). Moment rule . String . Mass carrier (50g) . 50g masses . Unknown mass . Instruction card		* 1 mark for using Principle of Moments practically. 1 mark for correct calculation 1 mark for correct answer
13 Use the apparatus provided to find the value in ohms of the resistance wire (or resistor). * Draw your circuit diagram.	The circuit could be set up by teacher or by students as part of the test. (For more advanced students, higher resistors and micro- and milliammeters could be provided).	13). Transformer . Switch . Wires . Voltmeter . Ammeter . Resistance (Nichrome) Wire (About 25cm) or Resistor	It may be desirable to check circuits before allowing students to continue with their designed experiments.	* 1 mark for correct reading on voltmeter and 1 mark for ammeter 1 mark for correct use of Ohm's Law; 1 mark for correct answer 1 mark for correct circuit diagram.
14 Find and record the average thickness of one sheet of paper. * Show working.	Students could be allowed to choose their own measuring instrument instead of being supplied with the micrometer.	14). Micrometer . Pad of 50 or 100 pages . Instruction card . Metre rule	Students should be told the number of pages in the pad.	* 1 mark for use of micrometer 1 mark for use of full pad; 1 mark of multiple readings 1 mark for correct average.

MEASUREMENT (ANALYSIS-DESIGN)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. What is the length and breadth of the piece of paper?		1) . Metric rule (30cm) . Sheet of paper		Unless mentioned marking could apply to all examples given.
2. What is the diameter of the brass mass?		2) . Brass density cylinder . 30cm rule . Metric rule . Vernier calipers . Micrometer . Instruction card		* 1 mark for each correct measurement. * 1 mark e.g. 5 marks overall for consistently giving units.
* Which piece of equipment did you measure this with?				
* Name two factors which should be considered when choosing a measurement instrument.				* If dealt with - could also award marks for indicating accuracy or possible error of each measurement.
3. What is the diameter of the piece of wire?		3) . Piece copper wire . Micrometer . Instruction card		
4. What are the dimensions of this desk - i.e. length, breadth, height?		4) . Metre rule . Instruction card		* Could award bonus marks for evidence of multiple readings and averages being taken, especially on small measurements
5. What is the internal and external diameter of the test tube?		5) . Large test tube . Vernier calipers . Instruction card		* Where applicable, 1 mark for correct choice of equipment (e.g. Q.2).
6. What is the length of this laboratory?		6) . Metre rule . Instruction card		* 1 mark where applicable for each reason which correctly justifies choice of equipment.
7. What is the distance between the two nails in the wall outside this room?		7) . Nails in wall . Metric tape (25m or 50m) as used in athletics measurements.	Any two reference points will suffice - if nails, ensure that they are firmly driven into the wall.	* 1 mark where correct order of accuracy is given. * 1 mark for a correct reason.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
8. Arrange and record the measuring instruments in order of increasing accuracy (Note that some may be of equal accuracy).		8) . Metre rule . 30cm rule . Vernier . Micrometer . Other rules if available . Metric tape . Sewing tape	Students should be advised to randomise the measuring instruments after use (teacher should check this).	

MEASUREMENT (LENGTH)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. Find and record the weight of the object given to you using the a) Spring balance b) Electric balance c) Triple arm balance. * Arrange the balances used in order of increasing accuracy. * Give a reason why the balance you chose as the least accurate is the least accurate. 71	Set up balances at various places in the laboratory. (OR) Supply each bench with one of each type of of balance, with electric balance(s) on the teacher's bench. Set time limit for use of each balance.	. Various objects to be weighed - Stones - Masses - Glass Lids - Small bottles - Stoppers - Bosshead - Crucible etc . Balances as specified - Spring balance - Electric balance - Triple Arm balance . Pieces of string, or 'string cradles' for Spring balances.	If each student has a different object, cheating will be minimized. Copying of usage could also be minimized by placing different types of balances together. Use of electric balance may have to continue on into the next period.	* 1 mark for each correct usage of significant figures for each balance. * 1 mark for correct order of increasing accuracy. * 1 mark for correct reason. 72

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* What is the reading on each piece of apparatus set up around the laboratory.	Set up whatever equipment is desired.	Equipment that could be used includes: . measuring cylinders - 10mL, 100mL, 500mL, 1000mL . Spring balance . Triple Arm balance . Ammeter . Voltmeter . Milliammeters . Microammeters . Newton Meter . Thermometers (including clinical, maximum, minimum . Barometer . Stopwatch . Micrometer . Vernier . Burette . Alpha spark counter . Decatron counter (Geiger counter)	Students needs to be instructed NOT to interfere with the equipment.	* 1 mark for each correct reading. OR * 2 marks for each correct reading; 1 mark for simple error (94.3, 94.2 etc). 0 for 'way-out' answers.

MEASUREMENT (READING SCALES)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. What is the temperature of the mixture which is boiling in the container?		1) . Hot plate . Boiling can . Methanol/Water mixture . Thermometer (0-100^{0}C) . Instruction card	Allow mixture to boil until constant boiling point mixture is achieved.	* 1 mark for correct temperature.
2. What is the temperature of the mixture in the calorimeter box (or Thermos)?		2) . Thermos flask (or calorimeter) . Ice/salt mixture . -10 - 100^{0}C thermometer . Instruction card . Stirrer	Main problem in temperature measurement is maintaining a constant temperature. Unknown to students these two previous will suffice very well.	* 1 mark for correct temperature.
3. What is the temperature of the liquid in the container?		3) . Large container of water (OR) small container in calorimeter box, (OR) water in thermox flask . Thermometer 0 - 100^{0}C . Instruction card	Large containers should ensure constantish temperature for duration of test. Thermos better.	* 1 mark for correct temperature (OR) 2,1,0 marks for correct, close or way-out.
75				76

MEASUREMENT (TEMPERATURE)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. How long does it take for the pendulum to swing to one side and back again?		1) . Pendulum(s) . Stopwatch(es) . Instruction card		* 1 mark for correct time
2. How long does it take for the ball to roll from X down the slope to Y?	Mark X and Y about 1 metre apart on the inclined plane. Time the ball beforehand.	2) . Steel ball . Inclined plane . Stopwatch . Chock for incline (or clamps and clampstands) . Instruction card	An electromagnet could be used to release the ball at start of each run.	* 1 mark for correct time.
3. How long does it take for the burette to empty from the zero mL mark to the fifty ml mark?		3) . Burette . Stopwatch . Instruction card	Time each burette beforehand several times to ensure consistency. Check outlet for possible blockages.	* 1 mark for correct time.
4. READ THESE INSTRUCTIONS FULLY BEFORE STARTING WORK. Pour solution A into solution B and note how long it takes before the mixture changes colour.	Teacher needs to set up as many sets of equipment as students doing the test. (It is suggested that each solution be contained in labelled 250mL conical flasks).	4) . Solution A 50mL Sodium Sulphite solution (1.26g dissolved in 1 litre of 0.03M Sulphuric Acid). . Solution B 25mL Potassium Iodate (4.28g/L and 165mL distilled water). . 10mL starch solution . Stopwatch . Instruction card	Time this reaction beforehand as the concentrations may vary marginally and alter the reaction time considerably. Reaction time = 29 secs (approximately). Starch solution should be freshly made.	* 1 mark for correct time.

This is a simpler version of some material on pages 38 and 39.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
1. What is the volume of the container (A) up to the mark on its side? * Which cylinder(s) did you use? * Why did you use this cylinder?	(This question eliminates the question "how much water is in the container?", which has errors associated with spillage by students, unless set up, as in Q.2).	1) . 100mL measuring cylinder . 500mL measuring cylinder . 1L measuring cylinder . Water . Instruction card . "Special" container labelled A.	For accuracy this requires a container with a narrow neck, such as a graduated flask. But conceal the specifications if used. Students to empty all containers after use.	Could also award credit or demerit marks for correct or incorrect usage of equipment or faults in technique as observed by teacher.
2. How much water is in the test tube?	As equipment for these volume measurements is also in plentiful supply, these questions could also be used to test students wise choice or correct choice of apparatus for each experiment, by supplying each bench with all the apparatus needed for the questions used.	2) . Labelled test tubes containing water and stoppered. . 100mL cylinder . Instruction card . "Used-tube" container	Put pre-measured amounts of water into labelled test tubes. Instruct students to indicate on their answer sheets, which tube they used. Students to empty measuring cylinder after use.	* Mark awarded for correct amount ± 0.5 mL (which allows for "left-over" water in the measuring cylinder from the previous student).
3. What is the maximum amount of water that can be poured into container A before it overflows?		3) . Yoghurt container labelled "A" . 100mL cylinder . Instruction card . Bench cloth (for spillages).	Students to wipe down desk before moving on. Make sure container A is dry before re-use by next student.	* As for Question 2.
4. What is the volume of the small metal/wooden cube?		4) . Metric rule (30cm) . Density cube (metal or wood) . Instruction card		See "Measurement - Length".
5. What is the volume of the stone? * Which stone did you use?	Several labelled stones of pre-determined volume will reduce cheating.	5) . 100mL cylinder . String . Stone(s) - labelled . Instruction card	Instruct or warn students not to drop objects into glass containers - slide them down the side. Students to empty measuring cylinder after use.	* Mark for correct answer ± error because of wet equipment.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
6. What is the volume of the large stone?	Expect students to use displacement of water and overflow method.	6) . Largish stone . Beaker of larger volume than stone . Suitable measuring cylinder . A pneumatic trough or bucket . Instruction card	Students to empty all containers after use.	
7. Arrange the containers A,B,C and D in order of increasing volume.		7) . Containers with labels . 100mL measuring cylinder . Instruction card	Students to empty all containers after use.	
8. Measure 20mL water into the measuring cylinder marked A. * Measure 20mL of Methylated Spirit into the cylinder marked B. * Add the water to the Methylated Spirit. * Record the total volume.	* Label measuring cylinders "A" and "B". * Label containers * Check total volume in containers before test.	8) . 2 x 100mL measuring cylinders . Container of water (or use tap) . Container of methylated spirit . Instruction card . Container for used mixture (if reclaiming)		(NOTE: Final volume will read less than 40mL - about 38mL). * 2 marks for 38mL 1 mark for other acceptable answer 0 marks for 40mL.
9. Arrange and record the containers A, B ... in order of increasing accuracy.	* Label containers "A","B", ...	9) . 10mL measuring cylinder . 100 mL measuring cylinder . 500mL measuring cylinder . Assorted beakers (Graduated and nongraduated) . Volumetric flask . Pipette . Test tube . Burette . Flasks etc. . Instruction card		* 1 mark for correct order of accuracy. * 1 mark for a correct reason.

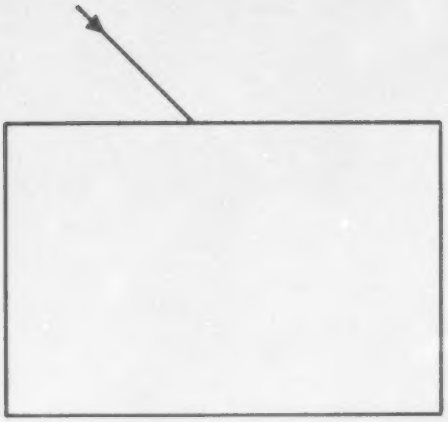
MEASUREMENT (VOLUME)

Examples of questions	Procedure	Equipment List	Special Requirements	Suggested Marking
* Observe what happens when the two chemicals supplied are added together. OR * List, in detail, the changes which occur when the contents of test-tube A are added to the solution in test-tube B. OR * Add chemical A to chemical A. What evidence is there to show that a chemical reaction has occurred?	The series of experiments described here can be done by: a) rotating students through laboratory stations; OR b) by providing each bench with the range of solutions required. * Students could be asked to a) test solutions with indicator before and after (may be some confusion with hydrolysis reactions - e.g. $CuSO_4$ solution is acidic); b) test any liberated gas; c) measure before and after temperatures. * Require student to wash and drain all apparatus as it is used, or at completion of test.	CHEMICALS The following solids or solutions may be useful. Some possible combinations are listed in the marking column. Required solutions may be diluted. A. 1.0M Ammonia sol'n. B. 30g/L Copper Sulphate sol'n (+ drop H_2SO_4) C. 0.05M Potassium Iodide sol'n (8g/L) D. 12g/L Lead Nitrate sol'n (+ drop HNO_3) E. 7g/L Silver Nitrate sol'n (+ drop HNO_3 - dark bottle). F. 16g/L Sodium Thiosulphate sol'n. G. 10g/L Mercuric Chloride sol'n. H. 2.0M Sodium Hydroxide sol'n. I. 2.0M Hydrochloric Acid sol'n. J. Ammonium Chloride (or nitrate) solid. K. Water L. 20g/L Sodium Carbonate sol'n. M. Methylated Spirits or Ethanol. N. Iron Sulphide solid OTHER EQUIPMENT . Containers for used equipment (pneumatic troughs) . Test tube racks. . Test tube brushes.	*Before* the test starts, students should be reminded of a) safety aspects of dealing with unknown solutions; b) careful use of equipment; particularly eyedropper contamination with other solutions; c) need to dispose of used solutions into waste containers (or sink); d) disposal of emptied or other used test tubes into "dirty equipment" container. e) Example (i) will require instructions to add (say) 10ml *K* to 10ml *M* in a 100ml measuring cylinder.	For the addition of the two chemicals: a) *A+B* Blue ppte. (1 mark) which dissolves in excess ammonia. b) *C+D* Yellow ppte. (1 mark). c) *E+F* White ppte. (1 mark) which slowly turns yellow, then red, brown, black (up to 4 marks). d) *C+G* Yellow ppte. (1 mark) which slowly turns orange (1 mark). e) *H+I* Exothermic process (1 mark). f) *J+K* Endothermic process (1 mark), solid dissolves (1 mark). g) *B+H* Blue-green gelatinous ppte. (1 mark), increase in volume (1 mark), recording amount of volume increase (1 mark). h) *I+L* Effervescent reaction (1 mark). Gas given off (1 mark). i) *K+M* Decrease in volume (1 mark) Record amount of decrease (1 mark). j) *I+N* Liberation of gas (1 mark) Odour of gas or recognition of gas by odour (1 mark)

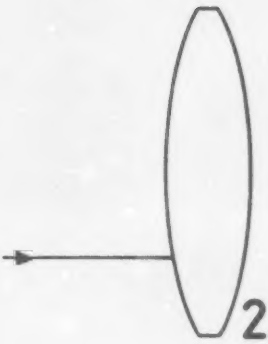
Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
Q.1. Look carefully at this organism and describe the nominated feature. (e.g. number of legs, type of body covering, head structure etc.) Q.2. Look at the organism and accurately draw it. Q.3. Look carefully at the organism and write a description of it which would allow another student to identify the same organism from your description. Q.4. Observe, the two specimens and list their differences. (e.g. two different flowers, two different strains of *Drosophila*. Q.5. Using the key provided identify the organism.	This test is best done by rotating students For a 10 station test include two of each type of question. Provide the organism and if appropriate a handlens, or stereo microscope and a key.	. Organisms or specimens that are to be used e.g. flies mosquito larvae grasshopper flowers shells . Handlens or stereo microscopes Classification keys	Kill organisms by immersing in 70% alcohol or by using an ether killing jar. Alternatively, use resin-mounted specimens.	1. Marks for correct identification. 2. Marks for: - drawing the organism approximately to scale - including observable features. - correct position of appendages 3. Marks for shape, relative size, colour and any special features. 4. Marks for correctly identifying each difference. 5. Mark for correct name.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* What is the path of the light on diagram ---? * What is the size of the angle of incidence on diagram ---? * What is the focal length of the lens in diagram ---? * What is the angle of refraction for light entering the glass slab on diagram 7?	1. Each student is supplied with a ray box kit and a sheet of diagrams indicating incident ray and reflecting or refracting object. Diagrams for both Harrison and Labax ray box kits are reproduced on the following pages. 2. This may be located at different stations around the laboratory - different diagrams being chosen for each station so as to avoid copying. See also p. 23	. Ray box kit . Power pack . Wires . Sheet of diagrams . Protractors . Rulers . Pencils	Ray box kit should contain functioning ray box, reversible gate, plane mirror, glass or perspex slab, prism and lens. A darkened space is essential. This need not be an entire room but may be (i) a curtained section of the laboratory or the preparation room; (ii) a screened bench; (iii) a large cardboard box. Not all of the diagrams are intended for use at the one time during the test. Suggest choosing one for each question used.	1 mark for correct drawing of the path of light. 1 mark for correctly using the normal. 1 mark for measuring an angle or distance correctly.

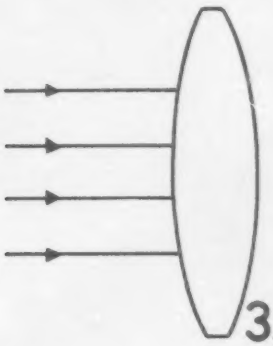
LABAX
KIT



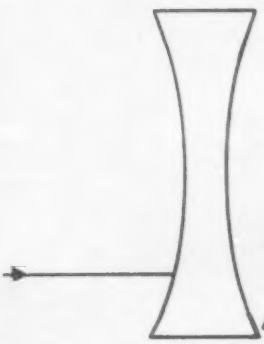
1. perspex slab



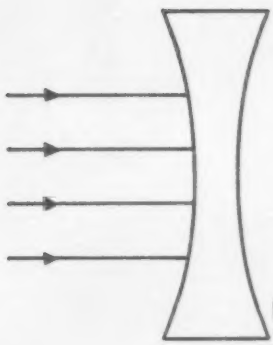
2. lens



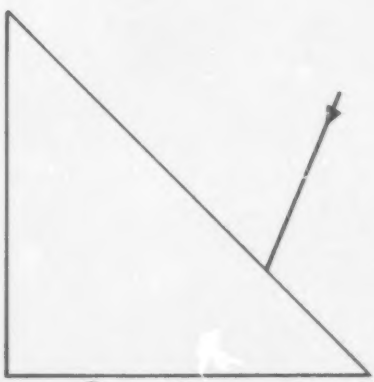
3. lens



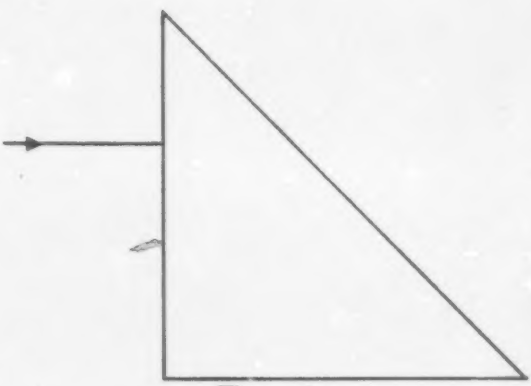
4. lens



5. lens

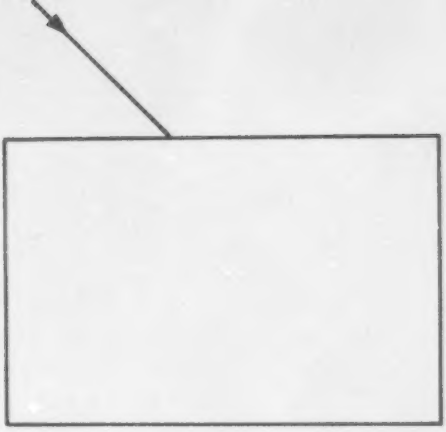


6. prism

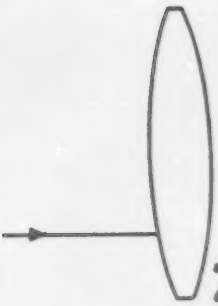


7. prism

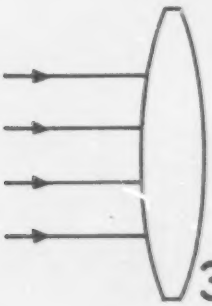
HARRISON KIT



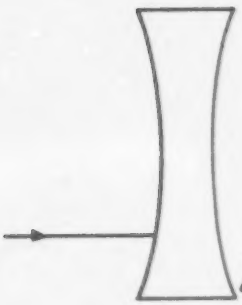
1. perspex slab



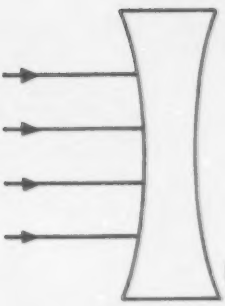
2. lens



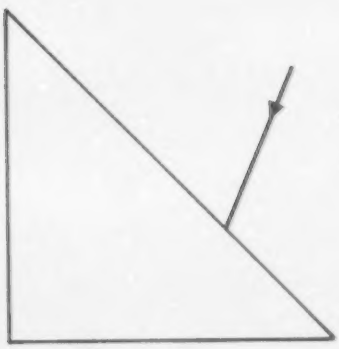
3. lens



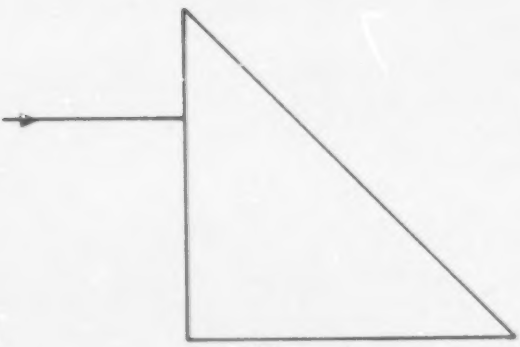
4. lens



5. lens



6. prism



7. prism

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Students could be asked to classify each rock (e.g. igneous, sedimentary metamorphic. * Which rock was formed in each environment? * What feature in the specimen causes you to make this choice.	1. Give students a hand lens and a set of rock specimens labelled 1, 2, 3 etc. 2. Allow students 5 to 10 minutes to familiarize themselves with the specimens. 3. Show the 35mm colour slides of the rock environments. 4. Ask students to select from the specimens the one most likely to have been formed in each environment.	. Hand lens . Rock specimens with obvious identifying characteristics. e.g. shale sandstone conglomerate limestone (fossiliferous) basalt (flow feature) volcanic: (pumice, tuff, breccia, obsidian) slate, gneiss schist . 35mm colour slides of rock environment e.g. mud feature in a lagoon beach or sand silted river pebble bar in a river coral debris adjacent to a reef fissure eruption exploding volcano highly folded rocks . 35mm slide projector and screen	Specimens should be chosen which clearly show one primary structure only and which cannot be misinterpreted. A possible source of some slides is: - the ASEP unit 'The Earth'	Marks can be awarded for: - correct classification - correct correlation with environment. - correct supporting reason(s)

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
* Look carefully at the specimens provided and decide the average grain-size of each. --- mm. * With reference to the table provided name the sediment in each specimen. * With reference to the table provided name each specimen.	Students are given unlabelled specimens of conglomerate and sandstone or 35mm colour slides. Students then observe and record answers.	. Specimen of conglomerate . Specimen of sandstone OR 35mm colour slide of sandstone and conglomerate . Projector or hand viewer . Rule . Hand lens . Wentworth scale (particle size classification refer SHSS 1970 ed. p.40-6, Table 40.1)	Since size is indicated in geological slides by the presence of a reference item e.g. coin, pen, hammer, these should be provided at the station for the student's reference.	Correct determination of average grainsize. Correct naming of the sediments. Correct naming of each specimen.
* Some sedimentary rocks are formed from pieces of broken down rock, some are formed chemically while others are formed by the action of living organisms. * Look carefully at the specimen provided and decide which way it was formed. * Give one reason for your choice.	Students are given an unlabelled specimen of limestone. Students then observe and record answers.	. Specimen of shelly (organically formed limestone) . Hand lens	The selected specimen must clearly show evidence of past organisms.	Correct method of formation chosen. Correct reason for the above choice.
* Look carefully at the two specimens provided. Which rock could be classified as shale? * State one feature you have observed in this specimen which enabled you to make this decision.	Students given specimens labelled A and B. They then make their observations and record their answers.	. Specimen of mudstone . Specimen of shale . Hand lens	The selected specimen should clearly show thin bedding in the shale.	Correct choice of shale with reason.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
SOIL - GRAIN SIZE * Estimate the average grain size of the particles in the soil samples provided.	1. Prior to the test prepare two minigrid slides, one of soil sample A and the other of soil sample B. 2. Provide the student with a monocular microscope, and the prepared slides. STUDENT ACTIVITY 1. Place slide on microscope stage and focus. 2. Determine the size of the soil grains you observe. Show your calculations.	. 2 dry soil samples A - sand B - clay . 2 minigrid slides . monocular microscope . lamp if conditions require it	The soil samples should be mounted in Curr's Water Mounting Medium so that the same slides can be used for each student.	Correct estimation of the average grain size. The selected samples should have average particle sizes within the range - . sand 0.2 - 0.02 mm . clay <0.002 mm

On this page and page 64, will be found an index to the *Practical Testing Guide*. This has been prepared to be of use to a person who has read through the *Guide* and recalls that a particular topic was mentioned.

Thus page 20 deals with observation of the circulatory system. It is listed in the index under

* Blood;
* Blood type;
* Circulation; and
* Observation.

The "key words" for each page have been selected solely as those most likely to allow the page to be located. They do not represent an endorsement of any curricular fad or trend.

The main science processes (e.g. "observation") are also indicated. It is hoped that this may assist the new reader.

* * * * * *

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Analysis ..... pp. 38,39,40,41
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Anion analysis ..... pp. 16,17
Application ..... p. 30
Basic measurement ..... p. 18
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Blood type ..... p. 20
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Chemical analysis ..... pp. 16,17
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Circulation ..... p. 20
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Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
THEORY PRETEST * How would you separate a mixture of sand and salt so that you obtained separate piles of (a) pure sand and (b) pure salt? * Mention, in order, every step you will carry out to do this.	* Ask students to write a point form summary of the experimental method they intend using. * Set a 10-15 minute time limit and then collect answers for later marking. NOTE: 1. This will enable you to distinguish those who know the procedure from those who copy other students' methods. 2. Practical skills of all students can still be determined in the practical side of test which follows. If they copy the method by watching others this does not matter as the practical side of the test deals with technique, rather than knowledge of method. 3. It may be better to give printed instructions to all students at this stage to ensure that all have an equal knowledge of the procedure.	(See below) This section deals with 10-15 minute theory pre-test.	Steps should include a) dissolving salt b) filtering mixture c) wash residue d) evaporate filtrate e) dry both f) weigh both g) record results h) statement of conclusion	Mark each method or experimental write-up out of (say) 10.
PRACTICAL TEST You have been given a mixture of sand and salt, * separate them from each other using the method you have (just described/ been given). CONTINUED ON NEXT PAGE	Supply each person with the equipment specified.	For each student . sand/salt mixture, 1 g salt, 2 g sand . filter paper and funnel . conical flask (250 mL) . wash bottle . evaporating basin CONTINUED ON NEXT PAGE	Suggest students complete to step (e) in first session, then leave samples (labelled) on bench or in incubator until next lesson. CONTINUED ON NEXT PAGE	a) subjective marking of errors in technique noticed as test is done, (say) /6. CONTINUED ON NEXT PAGE

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
CONTINUED * place the separated portions of salt and sand on the teacher's bench as indicated * record the mass of sand and salt you obtain. * Calculate the % of salt and sand in the original mixture.		CONTINUED . Bunsen, tripod, taper . incubator (if possible) set at 100^0C . centigram or triple-arm balance . stirring rod . distilled water <u>For teacher</u> . grid on bench for collecting student products - label with names . test-tubes, labelled with student names for chloride test . dropper bottle of silver nitrate solution (see marking)	CONTINUED This gives you opportunity to check-weigh each dry sample to allow marking of students weighings. See marking scheme (e). This also allows you to calculate marks as per marking scales (c) and (d) for each student. Weigh samples at room temperature for correct results.	CONTINUED b) weigh sand obtained and award 1 mark for each 0.2 g. Deduct 1 mark for each 0.2 g in excess of 2g = /10 c) test weighed sand samples in test tube for chloride content (use $AgNO_3$ solution) (say) /4 d) weigh salt and award 1 mark for each 0.1 g obtained. Deduct 1 mark for each 0.1 g in excess of 1 g = /10 e) award marks for student weighings of each sample. Deduct marks for various error ranges. Say 4 each = /8 f) 2 marks for correct percentage calculation. Test Total = 50.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
SOIL WATER RETENTION * Work out the amount of water retained by the soil. To do this subtract the amount you collected from the amount you added ... ml * Express the amount of water retained as a percentage of the weight of dry soil ... % * Is this soil suitable for plant growth? Give <u>one</u> reason for your answer. * Does the soil contain a large percentage of clay? Give <u>one</u> reason for your answer.	1. Soil sample will have to be dried and weighed and available for each student. 2. Retort stand and retort ring should be set up on the bench. STUDENT ACTIVITY 1. Place a small plug of cotton wool in the filter funnel. 2. Add the soil sample. 3. Measure and add 100mL of water and collect the water that drains through the soil in a measuring cylinder.	. Filter funnel . Plug of cotton wool . 1 x 100mL measuring cylinder . 100 g dry soil samples . 250mL beaker . Retort stand . Retort ring	A range of soils could be used and class results combined as stimulus for future lessons.	Correct calculation of the amount of water retained by the soil. Correct calculation of the percentage. Correct response and reason only. Correct response and reason only.
SOIL - ACIDITY * Compare the colour of your solution with the colours on the chart provided. What is the pH of your soil sample? * Is this an acid or an alkaline soil? Give a reason for your choice.	STUDENT ACTIVITY 1. Place about 2-3 cm of soil in a test tube. 2. Add a match head quantity of barium sulphate. 3. Add about 3 cm of distilled water, stopper and shake. 4. Place test tube in rack, remove stopper and add 1 or 2 drops of Universal indicator.	. Dry soil - enough for each student to take about 20 g . Fine precipitated $BaSO_4$ powder . Distilled water . Universal indicator in dropper bottle	<u>NOTE</u>: 1. This method gives approximate values only. Is not accurate. 2. the addition of $BaSO_4$ causes the finer particles (clay silt) to settle more quickly than if water alone is used, yet does not obscure the indicator colour.	Correct approximate pH value. Correct choice of alkaline <u>with</u> reason. No marks for choice alone.

Examples of questions	Procedure	Equipment list	Special requirements	Suggested Marking
	OR (BETTER) 1. Place about 2-3 cm of soil in a test tube. 2. Add an equal amount of water, stopper and shake. 3. Place test tube in rack, remove stopper and dip pH paper into the solution.	. pH colour chart for Universal indicator . 25 mm test tubes . Test tube rack . Rubber stopper for test tube OR . Dry soil . Test tube . Stopper . Distilled water . pH paper . Colour chart	3. Colours on pH charts are often unreliable. . Do not use Universal indicator in this case as suspended material makes colour identification difficult in a short time.	
* What is the volume of the soil and water mixture? ... ml * What percentage of empty space must there have been in the soil? ...% * What do you think occupied this space before you added the water?	1. Place 50mL of dry soil in the measuring cylinder labelled "Dry Soil Only". 2. Pour soil sample into cylinder "A". 3. Measure 50mL water in cylinder "B". 4. Add the water to the soil in cylinder A. 5. Allow the mixture to stand until soil appears wet throughout. 6. Wash contents of cylinder A into waste container at completion of experiment.	. Dry soil sample (sandy) . 3 measuring cylinders (100mL) . Label one cylinder "Dry Soil Only" . Label other cylinders "A" and "B" . Disposal container	. Students should be warned not to empty soil/water mixture into soil but wash into disposal container.	Correct st. tement of final volume. Correct calculation of percentage of air in sample. Correct choice of AIR as response.